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27SEP99 E479457-6 D01559
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# Request for grant of a patent

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| | | |
|---|---|---|
| 1. | Your reference | BKCD/NS/DBN.104a |
| 2. | Patent applica *(The Patent Offic* | **9922693.8** 25 SEP 1999 |
| 3. | Full name, address and postcode of the or of each applicant *(underline all surnames)* | Trikon Holdings Limited<br>Coed Rhedyn<br>Ringland Way<br>Newport<br>Gwent<br>NP6 2TA |
| | Patents ADP number *(if you know it)* | 743542001 |
| | If the applicant is a corporate body, give the country/state of its incorporation | United Kingdom |
| 4. | Title of the invention | Method and Apparatus for Forming a film on a Substrate. |
| 5. | Name of your agent *(if you have one)* | Wynne-Jones, Laine & James |
| | "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* | 22 Rodney Road<br>Cheltenham<br>GL50 1JJ |
| | Patents ADP number *(if you know it)* | 1792001 |

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
|---|---|---|
| | | |

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

| Number of earlier application | Date of filing *(day / month / year)* |
|---|---|
| | |

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
*a) any applicant named in part 3 is not an inventor, or*
*b) there is an inventor who is not named as an applicant, or*
*c) any named applicant is a corporate body.*
*See note (d))*

Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

| | |
|---|---|
| Continuation sheets of this form | |
| Description | 8 |
| Claim(s) | 0 |
| Abstract | 0 |
| Drawing(s) | 7 6+6 11 |

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

Any other documents *(please specify)*

11. I/We request the grant of a patent on the basis of this application.

Signature Wynne-Jones, Lainé & James Date

Wynne-Jones, Laine & James 24.9.99

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr. B. Dunlop 01242 515807

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Method and Apparatus for Forming a film on a Substrate

In our pending application No. 9914879.3, the contents of which are hereby incorporated by reference, we described a method for forming a film on a substrate comprising:

(a) positioning the substrate on the support in a chamber;

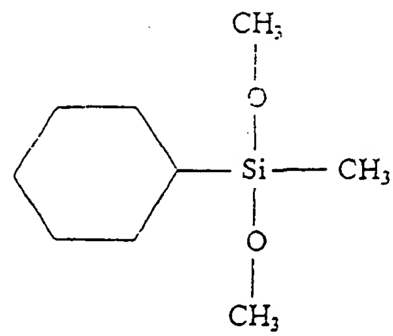
(b) supplying to the chamber in gaseous or vapour form a silicon containing organic compound and an oxidising agent in the presence of a plasma to deposit a film on the substrate; and

(c) setting (e.g. by annealing) the film such that carbon-containing groups are retained therein.

We suggest that the preferred oxidising agent is oxygen and indicate that the silicon-containing organic compound may be an alkylsilane or a tetralkylsilane.

Further experiments have now been carried out which suggest that methoxysilanes and in particular methoxymethylsilanes produce films with very low dielectric constants and may be particularly preferred.

Particularly good results have been achieved with cyclohexyldimethoxymethylsilane (CHDMMS) which has the following structure:



Experiments have also shown that a methoxysilane (e.g. CHDMMS may be able to be processed as in the above method described, but without any oxidising agent present in the plasma. It is supposed that this is because the Si-O bond already exists as part of the methoxy group.

Accordingly, according to another aspect the invention consists in a method of forming a film on a substrate comprising:

(a) positioning the substrate on a support in a chamber;

(b) supplying to the chamber in gaseous or vapour form an organic compound including an Si-O bond to deposit a film on the substrate; and

(c) setting (e.g. annealing) the film such that carbon-containing groups are retained therein.

Preferably the compound is supplied in the presence of a plasma, but other energy sources may be utilised to cause appropriate deposition and these may be combined with spin-on techniques.

As before the platen or support temperature may be low, and initial experiments as shown in Figure 6 were carried out at various temperatures from 0°C to 70°C. Subsequent experiments have been carried out with a platen temperature of 50°C rather than 0°C as previously described in British Patent Application No. 9914879.3.

The invention will be described with reference to the accompanying drawings, in which:

Figure 4 is a Fourier Transform Infra-Red (FTIR) spectrum for a first process run without oxygen; and

Figure 5 is the equivalent FTIR for the process run with oxygen;

Figure 6 is a table showing initial experimental results using standard delivery systems for CHDMMS;

Figure 7 is a table showing experimental results using a syringe pump to deliver CHDMMS; and

Figures 8 to 10 are FTIR spectrum relating to certain experiments identified in Figure 7.

An experiment has particularly been carried out using cyclohexyldrimethoxymethylsilane (CHDMMS). As is reported below this has shown significantly reduced dielectric constants. It is anticipated that benefits will be found from many methoxysilane compounds such as tetramethoxysilane.

The experiments were carried out in a chamber substantially as shown in Figure 1 of our co-pending application 9914879.3 with an electrode gap spacings of 40mm and 20mm and the uniformity ring shield used for non plasma based processes removed. The CHDMMS was fed into the chamber using a syringe delivery system described in our co-pending application (filed and entitled "Delivery of Liquid Precursors to Semiconductor Processing Reactors", which is incorporated herein by reference), on the same date as opposed to a traditional low vapour pressure mass flow controller. This was done due to the fact that, as described below, CHDMMS could not be reliably delivered by conventional means as it has a relatively high boiling point (approximately 200°C) compared to most of the other precursor materials investigated in application 9914879.3.

All processes were run with plasmas applied to the showerhead. All wafers were 'set' by annealing for typically 30 minutes at approximately 480°C.

The following parameter ranges have been investigated:

| | | |
|---|---|---|
| Pressure | - | 500 mT to 1500 mT |
| Power (380 kHz) | - | 50 W to 750 W |
| Platen temperature | - | 0°C to 70°C |
| CHDMMS flows | - | 0.5 g/min to 1.5 g/min |
| Oxygen flows | - | 0 to 200 sccm |
| Nitrogen flows | - | 0 to 400 sccm |
| Peroxide flows | - | 0 to 0.75 g/min |

It will be appreciated that the relative flow rates are particularly relevant to the process. In general higher rates lead to higher deposition rates and thus a broad range of flow rates can achieve similar results. Thus values outside the above ranges may be applicable.

Two particularly preferred process examples are given below: one of these is with oxygen and one is without oxygen.

| ***Process 1 (no $O_2$)*** | |
|---|---|
| Pressure | 900 mT |
| Power | 500 W |
| Platen temperature | 50°C |
| CHDMMS flow | 0.85 g/min |
| Nitrogen flow | 200 sccm |

| ***Process 2 (with $O_2$)*** | |
|---|---|
| Pressure | 900 mT |
| Power | 250 W |
| Platen temperature | 50°C |
| CHDMMS flow | 0.85 g/min |
| Oxygen flow | 50 sccm |
| Nitrogen flow | 150 sccm |

The resultant films were annealed and the post anneal results were as follows:

| ***Process 1 (no $O_2$)*** | |
|---|---|
| Deposition rate | 17000Å/min |
| Uniformity (max/min) | ± 4% |
| Refractive index | 1.370 |
| Dielectric constant | 2.55 |

| ***Process 2 (with $O_2$)*** | |
|---|---|
| Deposition rate | 9500Å/min |
| Uniformity (max/min) | ± 5% |
| Refractive index | 1.340 |
| Dielectric constant | 2.25 |

As can be seen the dielectric constants in each case are desirably low, but the "with oxygen" process is significantly advantageous.

Figures 4 and 5 show the respective FTIR spectra. It will be seen that they are substantially similar. The feature between 2500 and 2000 in Figure 5 is believed to result from atmospheric (background) $CO_2$.

In fact, initial experiments were carried out using a CHMMS source consisting of a PTFE pot within an evacuated aluminium vessel which was heated to 150°C. The pot was connected by gas line to a gas mass flow controller suitable for $H_2O$ with a conversion factor of 1.000. The RF power was applied to the showerhead with a spacing from the wafer of 40mm. The RF was 380khz continuous mode. Results from these experiments are shown in Figure 6. The

numbers in the CHMMS column are the nominal gas flow as measured by the mass flow controller however stable flows could not be achieved and therefore these results are for near random quantities of CHMMS being delivered to the process chamber. At this point experimentation was halted until a superior delivery system for this precursor could be developed.

CHMMS has a boiling point of 201.2°C, and a density of 0.940 g/cc. As it was noted in these experiments that CHMMS deposits a low k insulator without the addition of an oxidising agent it is therefore possible that it could be delivered as a liquid to a semiconductor wafer without a chamber being required (e.g. by well known 'spin-on' techniques) and then reacted either thermally or by plasma to form a low k (k<3) insulator layer. The apparatus used may in effect deposit a liquid by vaporising the liquid precursor, delivering it as a vapour and then condensing it onto the wafer at a temperature below the boiling point of the precursor at that pressure. It is not yet clear if the reactions take place to the precursor on the wafer or at some other place, depositing reaction products onto the wafer.

Having developed a more suitable liquid delivery system which utilises a syringe pump, further experiments

were carried out as shown in Figure 7. From these experiments preferred processes were developed as further described here. FTIR for runs 13, 14 and 16-23 respectively are illustrated in Figures 8 to 10.

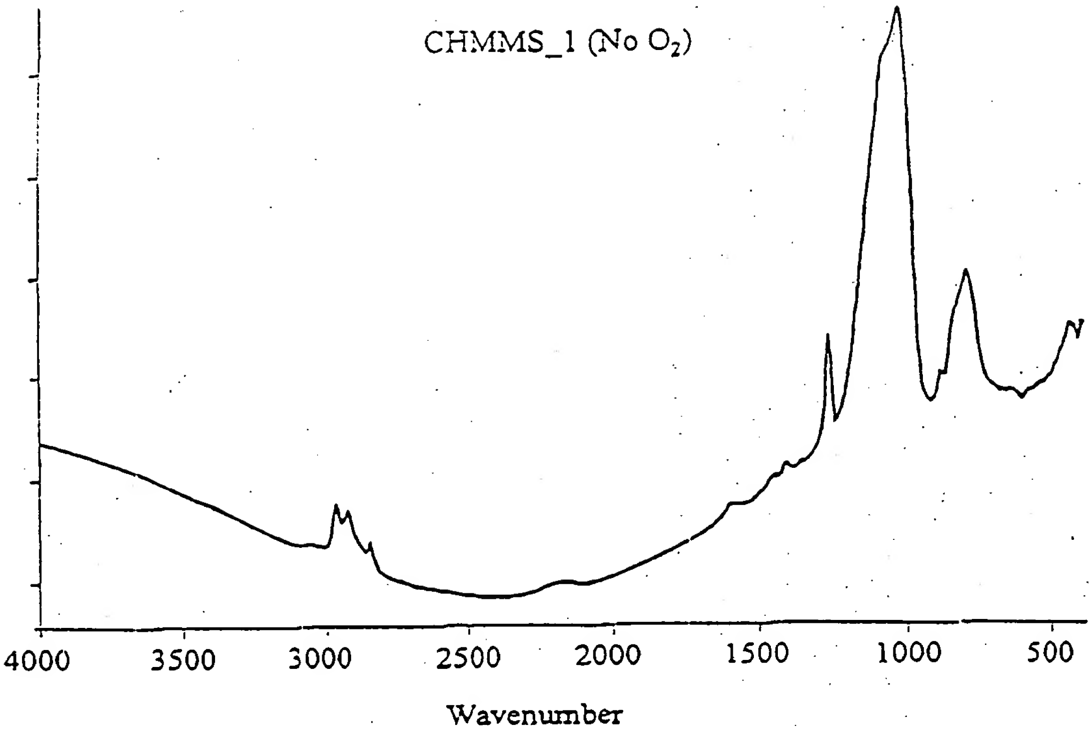

CHMMS_1 (No $O_2$)
4000
3500
3000
2500
2000
1500
1000
500
Wavenumber

FIG 4

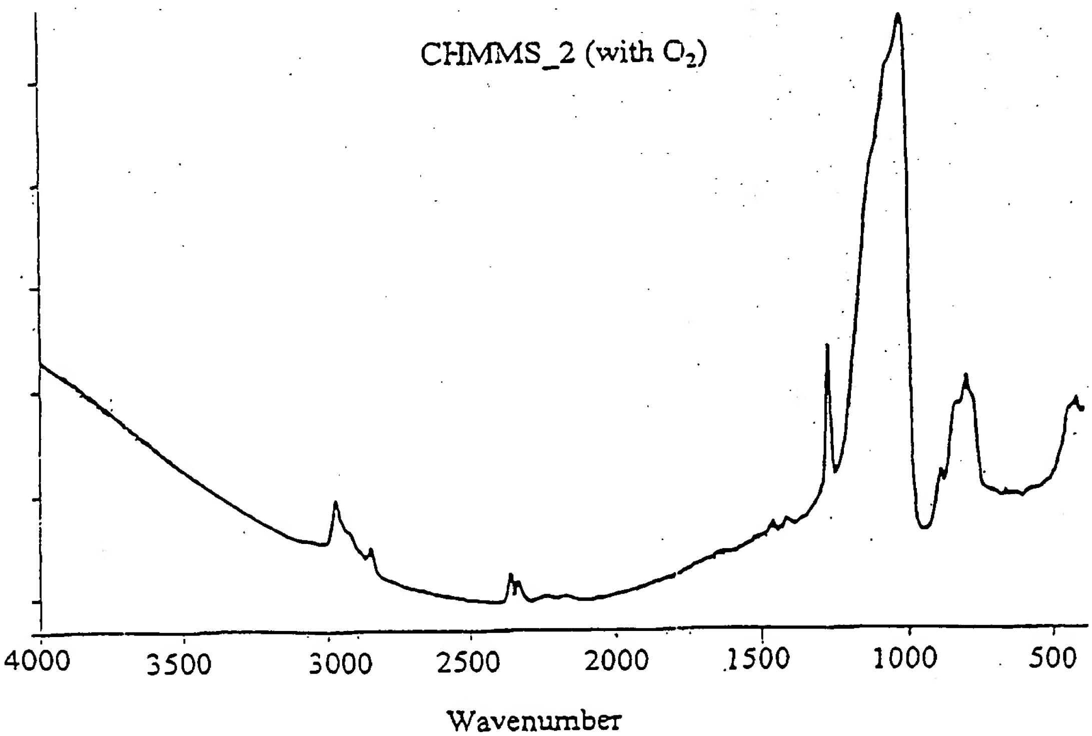

CHMMS_2 (with $O_2$)
4000
3500
3000
2500
2000
1500
1000
500
Wavenumber

FIG 5

| Date | Run No | CHMMS | $H_2O_2$ | $O_2$ | $N_2$ | RF Power (W) | Pressure (mT) | Platen (°C) | S/head (°C) | Dep Rate (Å/min) | Uniformity (%) | RI | R.I Range | SiC/SiO | SiH/SiO | CH/SiO | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1000 | 0.75 | 0 | 0 | 50 | 1500 | 70 | 100 | 1166 | 6.6 | 1.432 | 0.0007 | | | | |
| | | | | | | | | | | 681 | 5.1 | 1.3702 | 0.0074 | | | | |
| | 2 | 1300 | 0.75 | 0 | 0 | 50 | 900 | 70 | 100 | 2542 | 6.5 | 1.3321 | 0.01 | | | | |
| | 3 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 70 | 100 | 1853 | 6.1 | 1.3676 | 0.015 | | | | |
| | 4 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 70 | 100 | 1450 | 8.5 | 1.3498 | 0.0125 | | | | |
| | 6 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 70 | 100 | 3916 | 8.1 | 1.4736 | 0.0023 | | | | |
| | | | | | | | | | | 2008 | 8.3 | 1.3587 | 0.0075 | | | | |
| | 7 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 70 | 100 | 3965 | 22.1 | 1.5007 | | | | | |
| | | | | | | | | | | 2097 | 22.5 | 1.3749 | 0.005 | | | | |
| | 8 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 0 | 100 | 1392 | 13.5 | 1.4871 | 0.005 | | | | |
| | | | | | | | | | | 716 | 13.9 | 1.374 | 0.005 | | | | |
| | 9 | 1300 | 0.7 | 0 | 0 | 100 | 900 | 0 | 100 | | | | | | | | |
| | 10 | 1300 | 0.7 | 0 | 0 | 200 | 900 | 5 | 100 | 1176 | 27.3 | 1.4831 | 0.0106 | | | | |
| | | | | | | | | | | 738 | 25.6 | 1.4064 | 0.025 | | | | |
| | 11 | 1300 | 0.7 | 0 | 0 | 200 | 900 | 0 | 100 | ~2000 | | | | 0.0343 | 0 | 0.1062 | |
| | | | | | | | | | | | | | | 0.0191 | 0 | 0.0069 | |
| Pot Refilled 24/05/99 | 12 | 800 | 0.5 | 0 | 0 | 100 | 900 | 70 | 100 | 1731 | 15.9 | 1.4618 | 0.0163 | | | | |
| | 13 | 800 | 0.4 | 0 | 0 | 500 | 900 | 70 | 100 | 9938 | 35 | 1.458 | | 0.0153 | 0.0063 | 0.1102 | |
| | 14 | 800 | 0.4 | 0 | 0 | 250 | 900 | 70 | 100 | 2166 | 16.2 | 1.4569 | 0.0156 | | | | |
| | 15 | 800 | 0 | 0 | 0 | 500 | 900 | 70 | 100 | ~10000 | ~30 | 1.45 | | 0.0316 | 0.021 | 0.1715 | |
| | 16 | 800 | 0 | 0 | 0 | 250 | 900 | 70 | 100 | ~6000 | ~45 | | | 0.0299 | 0.0365 | 0.2756 | |
| | 17 | 800 | 0 | 0 | 0 | 250 | 900 | 70 | 100 | | | | | 0.0322 | 0.0376 | 0.303 | |
| | 18 | 800 | 0 | 0 | 0 | 250 | 900 | 70 | 100 | 5200 | | | | | | | 2.55 |
| | 19 | 800 | 0 | 0 | 0 | 250 | 900 | 70 | 100 | 7200 | | | | | | | 2.5-2.7 |
| | 20 | 800 | 0 | 0 | 0 | 250 | 900 | 40 | 100 | 5338 | 23.4 | 1.4938 | | 0.03 | 0.039 | 0.2353 | |
| 25/05/99 | 21 | 800 | 0 | 0 | 0 | 250 | 900 | 40 | 100 | 4200 | | | | | | | 3.2 |
| | 22 | 800 | 0 | 0 | 0 | 250 | 900 | 20 | 100 | 3641 | 14.4 | 1.4913 | 0.015 | 0.0396 | 0.027 | 0.237 | |
| | 23 | 800 | 0 | 0 | 0 | 250 | 900 | 20 | 100 | 6500 | | | | | | | 2.87 |

FIG 6

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# Flowfill chamber depositions using Cyclohexyldimethoxymethylsilane

P727 - Flowfill chamber (Flow_1), 40mm el ctrode gap - Syringe delivery system

**Process parameters** **Bulk Film Properties** FIG7

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.65 | 0 | 0 | 900 | 250 | 100 | 50 | 7224 | 10.6 | 1.4619 | | 0.0357 | 0.0111 | 0.1347 | Act. 1000mT , slight s/h |
| 2 | 0.65 | 0 | 0 | 900 | 250 | 100 | 50 | - | - | - | | 0.0345 | 0.0296 | 0.03672 | Peeled off in FTS |
| 3 | 0.65 | 0 | 100(1+8) | 900 | 250 | 100 | 50 | 8190 | 6.5 | 1.4875 | | 0.039 | 0.015 | 0.1545 | Plasma dark red |
| 4 | 0.65 | 0 | 50(1+8) | 900 | 250 | 100 | 50 | 5810 | 22.8 | 1.4652 | | 0.0354 | 0.0269 | 0.3499 | Purple Plasma |
| 5 | 0.65 | 0 | 50(1+8) | 900 | 250 | 100 | 50 | 8289 | 13.1 | 1.51 | | 0.0384 | 0.0107 | 0.131 | |
| 6 | 0.65 | 0 | 50(1+8) | 900 | 250 | 100 | 50 | 8906 | 4.4? | 1.5089 | | 0.0379 | 0.0139 | 0.1238 | |
| [illegible] | 0.65 | 0 | 100(1+8) | 900 | 250 | 100 | 50 | 8717 | 2.3? | 1.4475 | | 0.0364 | 0.0172 | 0.1886 | |
| [illegible] | 0.65 | 0 | 100(1+8) | 900 | 100 | 100 | 50 | 2789 | 9.2 | 1.4775 | | 0.0349 | 0.0367 | 0.3518 | RI wafer |
| 9 | 0.65 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 12748 | 3.4 | 1.489 | | | | | |
| 10 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 14222 | 1.7? | 1.538 | | | | | |
| 11 | 0.85 | 0 | 200(1) | 900 | 500 | 100 | 50 | 14192 | 1.5 | 1.5228 | | | | | |
| 12 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 14282 | 1 | 1.5444 | | | | | |
| 13 | 0.85 | 0 | 100(1+8) | 500 | 500 | 100 | 50 | 9790 | 3.7 | 1.4895 | | | | | |
| 14 | 0.85 | 0 | 100(1+8) | 500 | 500 | 100 | 50 | 11382 | 6.2 | 1.4468 | | | | | RI wafer |
| 15 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 19116 | 5.6 | 1.4634 | | | | | RI wafer |
| 16 | 0.65 | 0 | 100(1+8) | 900 | 250 | 100 | 50 | 10242 | 6.6 | 1.4558 | | | | | RI wafer |
| 17 | 0.65 | 0 | 100(1+8) | 900 | 250 | 100 | 50 | | | | 3* | | | | K=2.4 post oven anneal |
| 18 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | | | | 2.78* | | | | * Left overnight before measurement |
| 19 | 0.85 | 0 | 100(1+8) | 500 | 500 | 100 | 50 | | | | 2.82* | | | | K = 2.55 post oven anneal |
| 20 | 0.65 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | | | | 3.01* | | | | |
| 21 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 7869 | 7.8 | 1.5144 | | | | | Grainy film, 5min FTS |
| 22 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 15697 | 5.7 | 1.5387 | | | | | 5min FTS |
| 23 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 14751 | 3.5 | 1.4737 | | | | | 5min FTS |
| 24 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 14345 | 0.9 | 1.4737 | | | | | 10min FTS |
| 25 | 0.85 | 0 | 100(1+8) | 900 | 500 | 100 | 50 | 14079 | 1.6 | 1.4582 | | | | | 30min FTS |
| [illegible] | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 18864 | 4.5 | 1.4332 | | | | | 5min FTS |
| 27 | 0.85 | 0 | 200(8) | 900 | 750 | 100 | 50 | 17841 | 7.2 | 1.4327 | | | | | 5min FTS |
| 28 | 0.85 | 0 | 200(8) | 900 | 250 | 100 | 50 | 11511 | 6.3 | 1.4263 | | | | | 5min FTS |
| 29 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 15565 | 3.5 | 1.4856 | | 0.0317 | 0.0193 | 0.1366 | 5min FTS |
| 30 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 14807 | 3.1 | 1.4575 | | 0.0336 | 0.0096 | 0.0785 | 30min FTS |
| 31 | 0.85 | 0 | 200(8) | 900 | 750 | 100 | 50 | 16898 | 3.8 | 1.503 | | 0.0284 | 0.016 | 0.1418 | 5min FTS |
| 32 | 0.85 | 0 | 200(8) | 900 | 250 | 100 | 50 | 11658 | 11.5 | 1.499 | | 0.0342 | 0.0338 | 0.3437 | 5min FTS |
| 33 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | | | | 2.56 | | | | Depped with 30min FTS + Cap |
| 34 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | | | | 2.66 | | | | Depped with 30min FTS |
| 35 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 17106 | 3.7 | 1.4552 | | 0.0309 | 0.0199 | 0.1562 | 5min FTS |
| 36 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 17194 | 3.7 | 1.458 | | 0.031 | 0.0202 | 0.1498 | 5min FTS |
| 37 | 0.85 | 0 | 200(8) | 1200 | 500 | 100 | 50 | 24708 | 2.2 | 1.5316 | | 0.0311 | 0.0196 | 0.1338 | 5min FTS |
| 38 | [illegible] | 0 | 200(8) | 600 | 500 | 100 | 50 | 9953 | 1 | 1.5109 | | 0.0353 | 0.018 | 0.1283 | 5min FTS |
| 39 | [illegible] | 0 | 200(8) | 600 | 250 | 100 | 50 | 7128 | 0.8? | 1.5296 | | 0.035 | 0.0248 | 0.258 | 5min FTS |
| 40 | [illegible] | 50 | 150(8) | 900 | 250 | 100 | 50 | 9652 | 3.8 | 1.4575 | | 0.0285 | 0.0162 | 0.2006 | 5min FTS |
| 41 | 0.85 | 50 | 150(8) | 900 | 500 | 100 | 50 | 18448 | 3.8 | 1.4209 | | 0.0203 | 0.009 | 0.0839 | Feint powder showerhead pattern |
| 42 | 0.85 | 50 | 250(8) | 900 | 500 | 100 | 50 | ~1.8μm | - | - | | 0.0209 | 0.0058 | 0.0572 | Entire film cloudy |
| 43 | 0.85 | 200 | 0 | 900 | 500 | 100 | 50 | [illegible] | [illegible] | [illegible] | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94 | 0.85 | 50 | 0 | 900 | 500 | 100 | 50 | 21408 | 4.6 | 1.4199 | | 0.0273 | 0.0076 | 0.0725 | |
| 95 | 0.85 | 50 | 150(8) | 900 | 250 | 100 | 50 | | | | 2.49 | | | | 30min FTS, cap |
| 96 | 0.85 | 50 | 150(8) | 900 | 250 | 100 | 50 | | | | 2.48 | | | | 30min FTS, cap |
| 97 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 9917 | 8.8 | 1.4521 | | 0.0342 | 0.0093 | 0.1091 | 5min FTS |
| 98 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 9848 | 11.7 | 1.4592 | | 0.0334 | 0.0117 | 0.1441 | 5min FTS |
| 99 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | | | | 2.437 | | | | 5min FTS, cap |
| 100 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | | | | 2.286 | | | | 60min FTS, cap |
| 101 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | | | | 2.426 | | | | 30min FTS cap |
| 102 | 0.43 | 0 | 100(8) | 900 | 500 | 100 | 50 | 12080 | 7.6 | 1.5107 | | 0.0239 | 0.0093 | 0.096 | 5min FTS Showerhead dots |
| 103 | 0.43 | 0 | 100(8) | 900 | 500 | 100 | 50 | 12502 | 5.1 | 1.5081 | | 0.025 | 0.0119 | 0.0116 | 5min FTS Showerhead dots |
| 104 | 0.64 | 0 | 150(8) | 900 | 500 | 100 | 50 | 20470 | | | 2.9 | | | | 30min FTS cap |
| 105 | 0.85 | 0 | 400(8) | 900 | 750 | 100 | 50 | 14074 | 3.5 | 1.4983 | | 0.0282 | 0.0149 | 0.0912 | 5min FTS |
| 106 | 0.85 | 0 | 400(8) | 900 | 750 | 100 | 50 | 13930 | 2.4 | 1.496 | | 0.0278 | 0.0143 | 0.0771 | 30min FTS |
| [illegible] | 0.85 | 0 | 400(8) | 900 | 750 | 100 | 50 | | | | 2.72 | | | | 30min FTS CAP |
| CHAMBER SPACING CHANGED TO 20MM | | | | | | | | | | | | | | | |
| 108 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 17626 | - | 1.3437 | | | | | 30min FTS |
| 109 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 21765 | 8.4 | 1.3654 | | | | | 30min FTS, RI Wafer |
| 110 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 11436 | 17.6 | 1.3713 | | | | | 30min FTS |
| 111 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 12828 | 13.6 | 1.3888 | | | | | 30min FTS, RI Wafer |
| 112 | 0.85 | 0 | 200(8) | 600 | 500 | 100 | 50 | 14280 | 11.1 | 1.447 | | | | | 30min FTS, RI Wafer |
| 113 | 0.85 | 0 | 200(8) | 600 | 500 | 100 | 50 | 12185 | 3.4 | 1.3756 | | | | | 30min FTS |
| 114 | 0.85 | 0 | 200(8) | 400 | 500 | 100 | 50 | 9049 | 2.8 | 1.4745 | | | | | 30min FTS |
| 115 | 0.85 | 0 | 200(8) | 400 | 500 | 100 | 50 | 10620 | 8.6 | 1.4549 | | | | | 30min FTS, RI Wafer |
| 116 | 0.85 | 0 | 200(8) | 400 | 500 | 100 | 50 | 9073 | 3.5 | 1.4524 | | 0.0255 | 0.0143 | 0.0724 | 30min FTS |
| 117 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 14852 | 2.3 | 1.4384 | | 0.0343 | 0.0096 | 0.0865 | 30min FTS |
| 118 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | | | | 2.556 | | | | 30min FTS, Cap |
| 119 | 0.85 | 0 | 200(8) | 400 | 500 | 100 | 50 | | | | 2.76 | | | | 30min FTS, Cap |
| 120 | 0.85 | 0 | 200(8) | 900 | 500 | 100 | 50 | 11633 | | 1.4334 | | 0.0363 | 0.0094 | 0.0751 | 30min FTS, Stress = 8.78E8T |
| 121 | 0.85 | 0 | 200(8) | 900 | 250 | 100 | 50 | 8613 | | 1.399 | | 0.0386 | 0.0091 | 0.01019 | 30min FTS, Stress = 7.313E8T |
| 122 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 9207 | | 1.3954 | | 0.0329 | 0.0069 | 0.0493 | 30min FTS, Stress = 9.856E8T |
| 123 | 0.85 | 50 | 150(8) | 900 | 250 | 100 | 50 | 10515 | | 1.381 | | 0.0313 | 0.007 | 0.0502 | 30min FTS, Stress = 9.325E8T |
| [illegible] | 0.85 | 15 | 185(8) | 900 | 250 | 100 | 50 | 10640 | | 1.3807 | | 0.034 | 0.0051 | 0.0556 | 30min FTS, Stress = 9.041E8T |
| [illegible] | 0.85 | 75 | 125(8) | 900 | 250 | 100 | 50 | 11727 | | 1.3597 | | 0.0295 | 0.0042 | 0.0344 | 30min FTS, Stress = 8.544E8T |
| 126 | 0.85 | 100 | 100(8) | 900 | 250 | 100 | 50 | 12598 | | 1.3481 | | 0.0293 | 0.0056 | 0.0336 | 30min FTS, Stress = 8.778E8T |
| 127 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | 9206 | | 1.3718 | | 0.0331 | 0.0061 | 0.0466 | 30min FTS, Stress = 8.025E8T |
| 128 | 0.85 | 15 | 185(8) | 900 | 250 | 100 | 50 | | | | 2.414 | | | | 30min FTS |
| 129 | 0.85 | 75 | 125(8) | 900 | 250 | 100 | 50 | | | | 2.4 | | | | 30min FTS |
| 130 | 0.85 | 100 | 100(8) | 900 | 250 | 100 | 50 | | | | 2.49 | | | | 30min FTS |
| 131 | 0.85 | 25 | 175(8) | 900 | 250 | 100 | 50 | | | | 2.41 | | | | 30min FTS |
| 132 | 0.85 | 35 | 165(8) | 900 | 250 | 100 | 50 | | | | 2.48 | | | | 30min FTS |
| 133 | 0.85 | 15 | 185(8) | 900 | 250 | 100 | 50 | | | | 2.43 | | | | 30min FTS |
| 134 | 0.85 | 30 | 170(8) | 900 | 250 | 100 | 50 | | | | 2.45 | | | | 30min FTS |

FIG 7 (Cont'd)

**FTIR Spectra**

1.) 800CHMMS,0.4g/min H2O2, 900mT, 250W as deposited

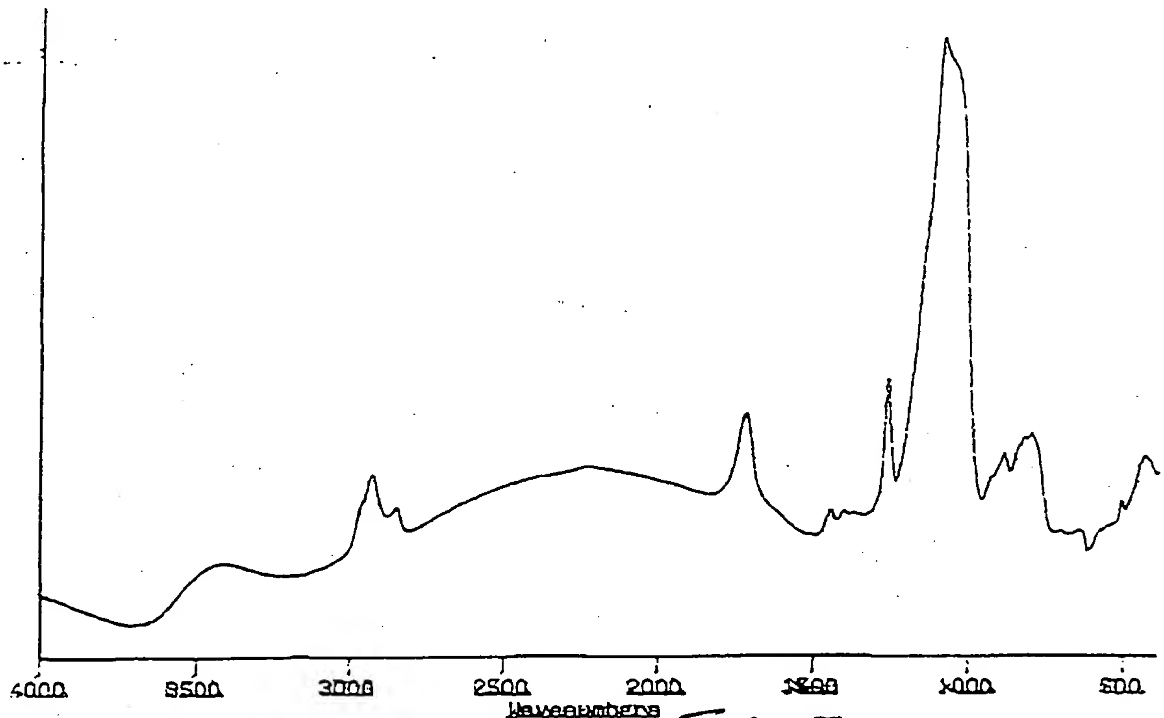


FIG 9

2.) 800Sccm CHMMS, 0.4g/min H2O2, 900mT, 500W

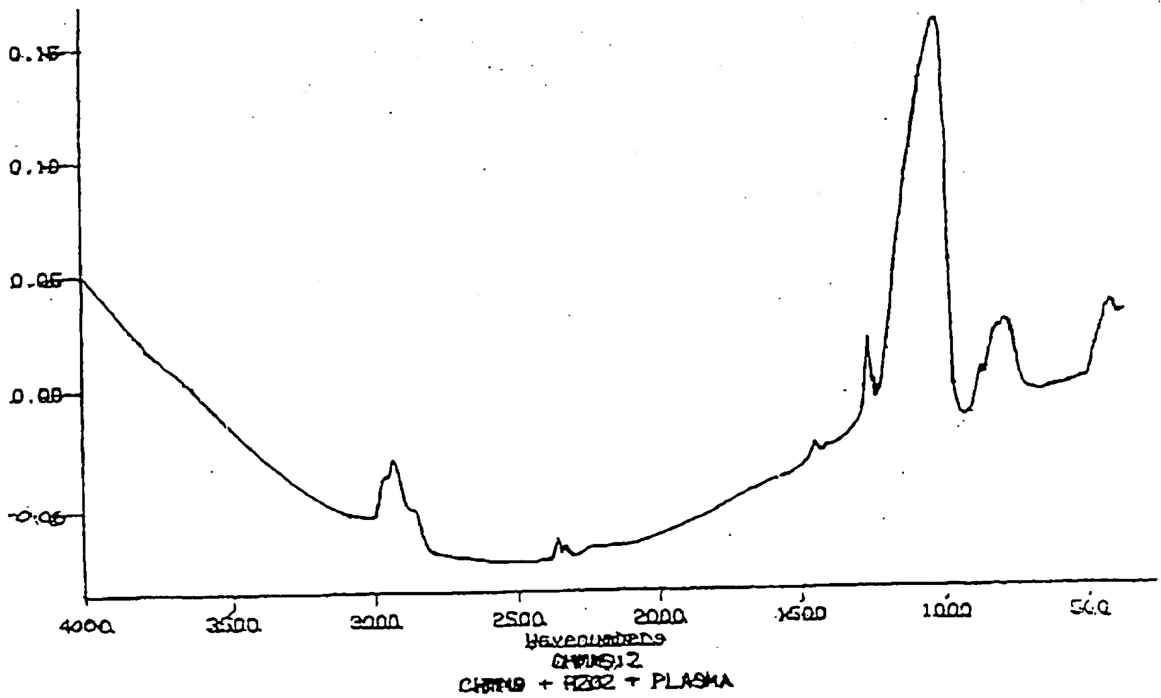


FIG 8.

3.) 800Sccm CHMMS, 900mT, 250W

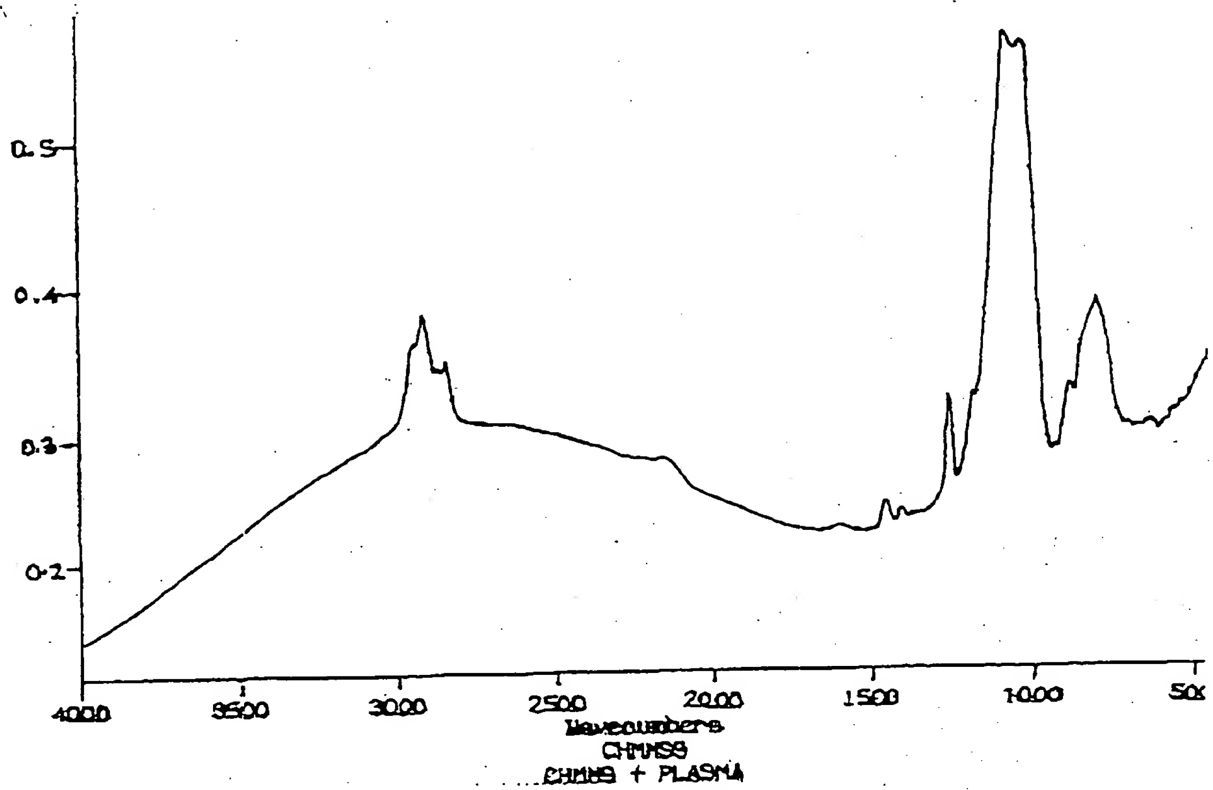


FIG10

ICT/GB001 301

6.7.00

Wynne-Jones Laine & James